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RACT (Reasonably Available Control Technology) Enforceability Aspects for Pneumatic Tire Manufacturing

PEDCo-Environmental, Inc., Cincinnati, OH

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16. ABSTRACT Pneumatic rubber tires or tread rubber is manufactured by 94 plants located in the United States and Puerto Rico. Reasonably available control technology (RACT) requirements for the pneumatic rubber tire and tread rubber manufacturers apply to 55 plants located in photochemical oxidant nonattainment areas. The major processing steps in tire manufacturing are rubber compounding, tread rubber production, cord production, bead production, tire building, and tire curing and finishing. The following processes cause volatile organic compound (VOC) emissions from a typical pneumatic tire manufacturing plant: green tire spraying with organic-based solvents, undertread cementing, tire building, tread-end cementing, and bead dipping. Practical VOC control measures are carbon adsorption and use of water-based spray for green tire spraying. Hand application of cement for tread-end cementing may be an acceptable control provided emissions meet some arbitrary limit. No practical control measure has been found for the emissions from tire building. The potential enforcement problems appear to be determining the capture efficiency of the VOC collection device, determining compliance, applying the bubble concept, and meeting compliance schedules. This report provides an inventory of the pneumatic rubber tire and tread rubber manufacturing plants, an industry process description, a review of the RACT requirements, and an evaluation of the model regulations to identify enforceability problems.

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SUMMARY

A total of 94 plants located in 27 states and Puerto Rico manufacture either pneumatic tires or tread rubber. The following table lists the number of plants in photochemical oxidant attainment and nonattainment areas that manufacture pneumatic tires for automobiles, trucks, and buses; pneumatic industrial tires; or tread rubber:

	Number of plants		
	Total	Attainment areas	Nonattainment areas
Pneumatic tires for automobiles, trucks, and buses	57	23	34
Pneumatic industrial tires	7	3	4
Tread rubber	30	13	17
	94	39	55

The model regulations only apply to those plants in photochemical oxidant nonattainment areas.

Daily production for 1978, obtained from either the January 1979 Modern Tire Dealer or estimated on the basis of employment figures was 1,012,700 pneumatic tires and 1,590,000 lb of tread rubber. However, economic conditions have caused a decline in the tire market. Seven tire plants operated by the five major U.S. tire companies have been closed since 1975. Seven additional closings are scheduled for late 1980. These affected plants are predominantly older bias pneumatic tire manufacturing facilities. At least four smaller companies either no longer manufacture automobile tires or have filed for bankruptcy.

The major processing steps in the manufacture of tires are rubber compounding, tread rubber production, cord production, bead production, tire building, and tire curing and finishing. Rubber compounding is the mixing of rubber and additives under

carefully controlled conditions to produce the material from which tires are formed. Tread rubber is produced by extruding compounded rubber through a die. Nylon, polyester, steel, fiberglass, or aramid cords are woven into fabrics and coated with rubber. These coated fabrics are used to reinforce the tire. The tire bead serves as the rim of the tire. The bead material is brass-plated steel wire that is rubber-coated. In the tire building operation, all of the tire components are assembled to produce a "green" or uncured tire. In tire curing, green tires are loaded into presses and cured at 100° to 200°C (212° to 400°F) with steam and/or hot water under pressure.

The three general types of tires are bias ply, bias belted, and radial. Bias ply tires have two or more plies at a bias (angle) to the tread. Bias-belted tires have one or more belts between the plies and the tread. The belts are also at a bias (angle) to the tread. Radial tires have belts extending from bead-to-bead and perpendicular to the tread.

The following processes cause major volatile organic compound (VOC) emissions from a typical pneumatic tire manufacturing plant: green tire spraying with organic-based solvents, producing 1600 kg VOC emissions/day (3520 lb/ day); undertread cementing, 1506 kg/day (3300 lb/day); and tire building, 528 kg/day (1160 lb/day). Processes that cause less significant VOC emissions are tread-end cementing, 240 kg/day (530 lb/day); and bead dipping, 131 kg/day (290 lb/day). These average emissions are based on a model tire plant producing 16,000 passenger tires/day. The data are taken directly from the Control Techniques Guideline (CTG)*.

Practical VOC control measures are carbon adsorption and use of water-based spray for green tire spraying. Hand application of cement for tread-end cementing may be an acceptable control provided emissions meet some arbitrary limit. Carbon adsorption

*U.S. Environmental Protection Agency. Control of Volatile Organic Emissions From Manufacture of Pneumatic Rubber Tires, EPA 450/2-78-030, December 1978.

or the use of the VOC exhaust stream as the air supply for the process steam boiler could be acceptable control measures for bead dipping in some instances although the high air volumes prevent application. No practical control measure has been found for the emissions from tire building, which has a dilute, high-volume exhaust stream.

PEDCo contacted representatives from air quality control agencies having tire and tread rubber manufacturing plants in their jurisdictions to verify our list of manufacturers. They also helped to determine the status of state emissions control programs for the pneumatic tire industry and to identify potential enforcement problems.

The potential enforcement problems appear to be determining the capture efficiency of the VOC collection device, determining compliance, applying the bubble concept, and meeting compliance schedules. Capture efficiency can only be determined by a material balance; thus, the inspector cannot determine the capture efficiency of the collection device in the field. The tire industry maintains records of total solvent purchases but does not keep records of solvent consumption by operation. Because records are not now kept, there will be resistance from industry to record individual process solvent usage. Compliance determination based on company records is not legally enforceable in some states; therefore, other compliance determining methods must be established. Applying the bubble concept in a pneumatic tire manufacturing plant will allow the tire industry to overcontrol and undercontrol processes based on economics. To successfully apply the bubble concept the "up to" clause in the model regulation must be clarified. The tire industry may also have some problems in meeting compliance schedules when a formulation change is the preferred choice of controlling VOC emissions. Because of product liability problems, process changes are usually evaluated in the laboratory, and then the tire is road tested under controlled conditions. Testing may require as long as twelve months. Compliance schedules may need to be lengthened in these cases.

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SECTION 1
INTRODUCTION

1.1 BACKGROUND

Emissions of volatile organic compounds (VOC) from the entire rubber industry were estimated to be 1.4×10^8 kilograms in 1976. Emissions from the tire industry segment accounted for 63 percent of that total, or 0.6 percent of total national organic emissions from stationary sources. The average tire plant is estimated to release 4000 kilograms of VOC per day. The emitted VOCs are predominantly white gasoline and petroleum naphtha. Other emissions include toluene, xylene, benzene, isopropanol, ketones, and esters.

1.2 PURPOSE AND SCOPE OF REPORT

Regulations appearing in the Federal Register on August 28, 1977, require states to submit revised State Implementation Plan (SIP) revisions by July 1, 1980, reflecting VOC regulations for the pneumatic tire manufacturing industry. The Control Techniques Guideline (CTG), published in December 1978 by the U.S. Environmental Protection Agency (EPA), identifies VOC emission reduction systems for undertread and tread-end cementing, bead wire dipping, and green tire spraying.[1] The rubber tire industry believes that some VOC emission controls are too costly and consume substantial amounts of energy.

This report will aid the Division of Stationary Source Enforcement and state and local agencies by providing the following information:

An inventory of operating pneumatic rubber tire and tread rubber plants, with an identification of those that are subject to regulation because they are in nonattainment areas.

A brief review of the industry's ability to install and implement control measures, and of probable industry response to the regulations. Plant visits to 4 pneumatic tire manufacturing plants were used to gather this information.

A summary of pneumatic tire and tread rubber manufacturing processes, control equipment, and capture methodology. This information can be used to determine reasonable compliance schedules and potential problems in design of control equipment.

Plans by state air quality control agencies for regulation and enforcement.

SECTION 2

INVENTORY OF THE TIRE INDUSTRY

In order to determine the plants that might be potentially subject to the model regulations, it was necessary to compile a list of all the pneumatic tire and tread manufacturing plants in the United States. PEDCo used available data sources that contain lists of pneumatic tire and tread rubber manufacturing plants, contacted individual plants by telephone to resolve any discrepancies, and contacted the 10 EPA regional offices and 27 state air quality control agencies to verify the number plants located within their jurisdictions.

DATA SOURCES

PEDCo used the following eight data sources to compile this inventory of pneumatic tire manufacturing plants and tread rubber plants:

1. 1978 Rubber Red Book, 30th Edition, published by Palmerston Publishing Company, Inc., Atlanta, Georgia.

2. 1979 Rubber Red Book, 31st Edition, published by Palmerston Publishing Company, Inc., Atlanta, Georgia.

3. List of tire manufacturers published in the January 1978 issue of Modern Tire Dealer.

4. List of tire manufacturers published in the January 1979 issue of Modern Tire Dealer, with an update furnished by Mr. Chuck Slaybaugh, Editorial Director.

5. 10-K Reports submitted to the Securities and Exchange Commission by rubber manufacturers with publicly held stock.

6. Indices of Manufacturers from all 50 states and the District of Columbia as compiled by the Dallas Public Library.

7. Quick Look Report compiled by the EPA Compliance Data System.

8. List of tire manufacturers contained in the EPA Control Technology Guidelines. (The primary reference used in this source was a list of tire manufacturers published by Rubber World in its February 1978 issue. Rubber World's list had been taken from the January 1978 issue of Modern Tire Dealer, Source 3 of this list.)

All companies indicated as manufacturers of pneumatic tires or tread rubber were contacted by telephone. Plant closings, business reorganizations, and mergers were noted. Misinformation was corrected.

The sources provided a method for estimating and checking production rates and other information. For instance, the list published in Modern Tire Dealer included production estimates for each plant. The Rubber Red Book and Indices of Manufacturers frequently estimated the number of employees at particular plants. When the number of employees at individual plants was compared with production estimates, it was possible to make a correlation between the two. One tread manufacturer voluntarily disclosed the production rate at his plant. His employment level was given in the Rubber Red Book. Employment levels could then be used to estimate tread rubber production capacity at other plants.

The "States Attainment Status of National Ambient Air Quality Standards," published in the Federal Register on March 3, 1978, was used to determine which plants are in photochemical oxidant attainment or nonattainment areas. In the appendix we have listed the counties and Air Quality Control Regions (AQCR) in which the plants are located. Changes in attainment status were reported in the Federal Register on September 11, September 12, and October 5, 1978; this report incorporates those changes. In January 1979, approval of new National Ambient Air

Quality Standards (NAAQS) for photochemical oxidants also affected the attainment status of several areas, and this report reflects those changes.

FINDINGS

The inventory identified 94 plants in 27 states and Puerto Rico. The plants are grouped into three categories: 1) pneumatic passenger tire plants; 2) pneumatic industrial tire plants; and 3) tread rubber plants. The plants are grouped by EPA region in Table 1 and by state in Table 2. Individual plants and estimated capacities are presented in the appendix on a regional and state-by-state basis.

Pneumatic passenger tire manufacturers primarily make automobile, truck, and bus tires. This category includes 57 plants operated by 16 companies; 23 of the plants are in attainment areas and 34 are in nonattainment areas.

Industrial pneumatic tire plants make tires for forklifts, electric cars, and other vehicles for industrial use employing standard pneumatic tire-making equipment. They do not make automobile, truck, bus, or airplane tires. This category includes seven plants operated by seven companies; three of the plants are in attainment areas and four are in nonattainment areas.

Tread rubber manufacturers make tire tread for recapping worn tires. This category includes 30 plants operated by 19 companies; 13 of the plants are in attainment areas and 17 are in nonattainment areas.

Some listed industrial tire and tread manufacturing plants may be exempt from proposed VOC regulations for one of the following reasons:

1. They manufacture small volumes of speciality tires.

2. They manufacture tires in short production runs, but tires are only a minor part of their operation. Most of their products are not subject to the proposed VOC regulations. Guidance to states in determining exemptions is contained in the CTG.

TABLE 1. DISTRIBUTION AND CAPACITY OF TIRE AND TREAD RUBBER MANUFACTURING PLANTS BY EPA REGION.

Region	Number of plants						Estimated total capacity[b]		
	Attainment areas			Nonattainment areas			Tires, thousands/day		Tread rubber,[c] thousands of lb/day
	Car/truck tires	Industrial tires[a]	Tread rubber	Car/truck tires	Industrial tires[a]	Tread rubber	Passenger cars	Other vehicles	
I	0	0	0	2	1	0	34.5	6.0	0
II	0	0	1	2	0	1	11.1	9.1	75
III	2	0	0	5	0	2	63.6	38.5	105
IV	12	3	10	5	1	3	306.6	64.8	700
V	3	0	0	13	2	3	148.3	78.9	110
VI	5	0	2	2	0	2	136.4	20.8	220
VII	1	0	0	2	0	1	49.0	13.5	100
VIII	0	0	0	0	0	0	0.0	0.0	0
IX	0	0	0	3	0	4	27.3	4.3	240
X	0	0	0	0	0	1	0.0	0.0	40
TOTALS	23	3	13	34	4	17	776.8	235.9	1590

[a]Some of this production will not be subject to the proposed regulation. Tires may be nonpneumatic, oversized, or bicycle tires.

[b]Estimates are from the January 1979 "Modern Tire Dealer," unless otherwise noted.

[c]Estimates are based upon employment levels.

TABLE 2. DISTRIBUTION OF TIRE AND TREAD RUBBER MANUFACTURING PLANTS BY STATE.

State	Number of plants					
	Attainment areas			Nonattainment areas		
	Car/truck tires	Industrial tires	Tread rubber	Car/truck tires	Industrial tires	Tread rubber
Alabama	4	1	3	1	0	0
Arkansas	1	0	0	0	0	0
California	0	0	0	3	0	4
Connecticut	0	0	0	1	0	0
Georgia	1	0	3	0	0	2
Illinois	2	0	0	2	1	0
Indiana	0	0	0	1	0	0
Iowa	0	0	0	2	0	1
Kansas	1	0	0	0	0	0
Kentucky	1	1	0	0	0	0
Maine	0	0	0	0	1	0
Maryland	1	0	0	0	0	0
Massachusetts	0	0	0	1	0	0
Michigan	0	0	0	2	0	0
Mississippi	1	0	0	0	0	0
New Jersey	0	0	0	1	0	1
New York	0	0	0	1	0	0
North Carolina	2	1	3	1	0	1
Ohio	0	0	0	8	1	3
Oklahoma	3	0	0	1	0	0
Oregon	0	0	0	0	0	1
Pennsylvania	0	0	0	4	0	1
South Carolina	2	0	1	0	0	0
Tennessee	1	0	0	3	1	0
Texas	1	0	2	1	0	2
Virginia	1	0	0	1	0	1
Wisconsin	1	0	0	0	0	0
Puerto Rico	0	0	1	0	0	0
TOTALS	23	3	13	34	4	17

3. They manufacture small volumes of tread rubber. For example, some of the tread rubber manufacturers in California may be exempt from the VOC regulations because California's proposed regulations exempt sources emitting less than 200 pounds of VOC per day.

4. Tread manufacturers may not have undertread cement operations.

5. Tread rubber is manufactured at some recapping plants operated by major rubber companies. These plants, some of which use undertread cement, are not included in the survey.

All plants that are potentially subject to regulation have been listed because the proposed regulations might be revised; also, some states might adopt regulations more stringent than called for by Federal standards.

INDUSTRY TRENDS AND ECONOMICS

Economic conditions over the last few years and the popularity of the longer-lasting radial tire have caused a decline in the pneumatic passenger tire market. Seven tire plants have closed since 1975 and seven additional closings are scheduled for late 1980. Several of the smaller tire manufacturers no longer make pneumatic passenger tires.

Automobile and Truck Tires

The five major domestic manufacturers of automobile and truck tires are Firestone, Goodyear, Goodrich, General, and Uniroyal. English-owned Dunlop and French-owned Michelin also have significant manufacturing operations in the United States. Three small manufacturers that produce 11 percent of the domestic tires are Armstrong, Cooper, and Mohawk.

These three smaller manufacturers have survived primarily because each has at least one major customer. Armstrong makes tires for Sears. Cooper makes tires for Hercules Tire and Rubber, a wholesale buying group that sells to independent tire dealers. Even so, Cooper describes its tire operations as "struggling" to remain profitable. Mohawk sells tires to K-Mart and

Montgomery Ward. Armstrong and Cooper have other profitable operations to offset marginal tire profits.

McCreary Tire and Denman Rubber Manufacturing Company have abandoned the automobile tire market but continue to make other pneumatic tires. Super Tire Engineering Company makes pneumatic tires other than automobile tires, and Universal Tire Company manufactures tires for antique cars. IRI, Inc. and Mansfield Tire and Rubber Company, subsidiary of Inland Rubber, filed for bankruptcy in 1979. They no longer make pneumatic tires.

The passenger tire market is shrinking. The popular radial tire lasts longer than tire companies had anticipated, and lighterweight cars reduce tire wear. Because of market weakness, gasoline shortages, rising gasoline prices, and falling auto sales, Goodyear predicted that automobile tire shipments would drop 11 percent from 1978 levels. They also predicted an 8 percent drop for truck tire shipments. Goodyear has indicated a loss for the third quarter of 1979. Uniroyal lost $10 million in the third quarter of 1979 and projects a loss of about $20 million for the entire year.

The five major rubber companies have closed seven passenger tire manufacturing facilities since 1975. Firestone closed plants in Akron, Ohio, and in Los Angeles. Goodyear, Goodrich, and Uniroyal closed plants in Los Angeles. Goodyear closed a plant in Akron and its Lee Tire and Rubber subsidiary in Conshohocken, Pennsylvania. Mohawk Rubber Company closed two of its three plants. Uniroyal will close plants in Detroit and Chicopee, Massachusetts, in late 1980. Passenger tires are no longer manufactured in Akron or Los Angeles; previously these cities were principal locations for passenger tire production. Some companies have relocated their operations into Southern states primarily to take advantage of lower labor costs.

Industry representatives indicate that high costs to meet potential VOC control regulations may lead to the closing of additional plants. Whether or not this is true, the industry is not healthy.

Industrial Tires

Industrial tires are used on off-the-road vehicles such as forklift trucks. Most of the tires are solid rubber, but seven manufacturers produce pneumatic tires for these vehicles. Pneumatic tires appear to be a minor part of the production of these seven companies. For comparison, a typical automobile or truck tire plant employs a thousand or more people, but an industrial tire plant employs a few hundred. Hence, industrial pneumatic tire manufacturing is comparatively minor.

Tread Rubber Manufacturing

Nineteen companies in the United States and Puerto Rico operate thirty tread rubber manufacturing plants. They produce rubber for retreading automobile, truck, and bus tires. Tread rubber plants are relatively small. The larger of these plants employs about 100 people. Some of the plants produce other goods at the same site. These other production processes are not subject to the proposed VOC regulations. National employment by tread rubber manufacturers is about 3000 people; or only twice the employment of an average automobile tire manufacturing plant.

SECTION 3

DESCRIPTION OF INDUSTRY

PROCESSING STEPS

Pneumatic rubber tires are produced through a number of different processing steps. These steps include rubber compounding; tread rubber, cord, and bead production; tire building; green tire spraying; and tire curing and finishing. Figure 1 is a flow diagram of this sequence of operations necessary to produce a finished pneumatic tire.

Rubber Compounding

Only 60 to 70 percent of the weight of a tire is rubber. Several different rubber compounds are used in passenger car tires. The most common rubber compounds are styrene-butadiene, natural rubber, polyisoprene (to replace natural rubber), and polybutadiene. All rubber compounds are prepared in basically the same manner. Breakdown is the first step in rubber processing. The purpose is to soften and work rubber so that other ingredients can be blended in to make a uniform product. A Banbury mixer is commonly used for working and blending rubber. The Banbury mixer customarily operates at 275.8 to 551.6 kPa (40 to 80 psia) and at 150°C (300°F).

After breakdown, the rubber and additives are blended to a uniform dispersion. Generally the order of addition to the Banbury is (1) rubber, (2) plasticizers and softeners, (3) reinforcing agents and fillers, (4) sulfur or other curing agents, and (5) accelerators.

After mixing, the rubber compound is usually dipped in a cooling bath and stored in a cool room.

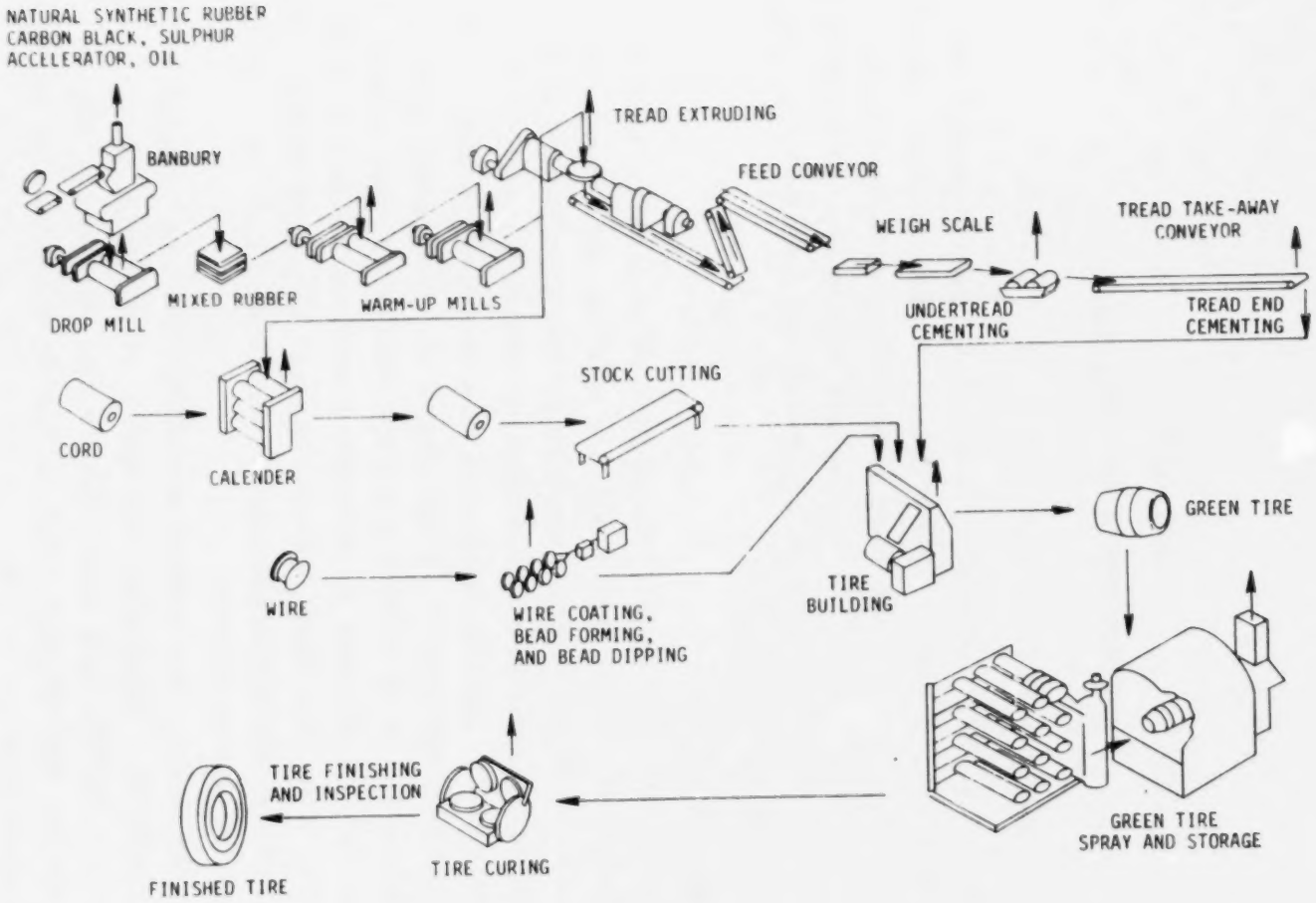

Figure 1. Tire manufacturing flow diagram.

Tread Rubber Production

Rubber compound is extruded to form tread. If the rubber has been stored and cooled, it is run through a warming mill before being fed into the extruder. Most extruders are of the screw type in which the screw forces rubber through a die. Following extrusion, the continuous stream of uncured tread is bevel cut to a predetermined length, weighed, cooled, and cemented. The feed into an extruder must be clean. Dirt and agglomerates are removed by straining through a screen. Operating conditions are closely controlled. Tire sidewalls and bead wire coating are also extruded.

The tire tread is cemented to the body or carcass of the tire. If the cement is properly applied, the tread-to-carcass bond is stronger than the body of the tire. Evaporated solvent from the tread cementing operation is a major source of VOC emissions. A typical tire plant emits about 1520 kg VOC/day (3350 lb/day) in an 11.2-m^3/s airstream (23,600 cfm) containing 1.57 g VOC/m^3 (385 ppm).

After the tread is cemented to the tire, the tread ends are cemented together. For a typical tire plant, VOC emissions as a result of tread-end cementing are estimated at 240 kg/day (530 lb/day) in an airstream of 15.6 m^3/s (32,800 cfm) containing 0.18 g VOC/m^3 (44 ppm).

Various adhesives are used in the tire manufacturing process. It is a difficult task to bond tire cord, steel, and the other components of a tire together. Adhesive solvents are significant VOC sources; factors in the selection of adhesives are discussed below.

Molecular, chemical, and mechanical bonds affect the strength of an adhesive. Molecular bonding is achieved through (1) the adsorption of adhesive ingredient chemicals on the fiber surface, (2) diffusion of other adhesive components (including solvents) into the fiber polymer and the rubber compound, and (3) physiochemical activity. Chemical bonding results from

chemical reactions between the adhesive, fabric, and rubber. The type and number of functional groups and the mobility of the various molecules in the bond are important. Mechanical bonding occurs when the adhesive fills the space between the materials to be bonded.

Important properties in adhesive bonding are reactivity and surface and finish characteristics. Each material has a different reactivity. For example, rayon has many reactive hydroxyl groups; nylon is less reactive but has highly polar amide linkages. Polyester is quite inert. The adhesive bond also depends upon the degree of contact between the two surfaces. Rough and soft surfaces would be preferable to smooth and hard surfaces.

Because the adhesive must bond to rubber, the type and nature of the rubber is important and must be considered. Natural and synthetic rubbers have different chemical properties which may dictate the choice of adhesive. The other ingredients in the compounded rubber also are factors in this choice.

A good adhesive system has the following characteristics:

Rapid adhesion
Compatibility with other materials
No adverse effects on tire properties
Good heat resistance
Good aging resistance
Good tack
Mechanical stability

The adhesive bond must remain strong through years of service under a wide range of conditions. The consequences of failure can be very serious. A rubber company may be reluctant to change a proven adhesive formula.

The industry manufactures significant amounts of rubber for retreading sound tire carcasses. Truck, aircraft, and bus tires are routinely retreaded. Retreaded automobiles tires are lower in cost but generally wear faster than a new tire.

Tread rubber produced in retread plants is much the same as that produced in a tire plant. The rubber compound is extruded to produce the tire tread. Retreaders can either purchase or mix

their own rubber compounds. After extrusion, some manufacturers coat the undertread with an adhesive cement and use a polyethylene liner to keep treads from sticking together during handling and shipping. Other tread manufacturers do not apply cement before shipping. Rather, the retreader applies the cement prior to bonding the tread to the tire carcass.

The VOC emissions from tread rubber plants have not been estimated or measured, but emissions from plants that apply undertread adhesive are probably similar to emissions from undertread cement operations in a tire manufacturing plant. Retread rubber plants are smaller than tire manufacturing plants, so total VOC emissions are less.

Cord Production

Rubber-coated tire cord makes up a significant part of the body of a tire. The cord reinforces rubber much as steel reinforces concrete. Tire cord also provides fatigue resistance and gives the tire shape, size stability, bruise resistance, and load-carrying capacity. Materials that have been found suitable for use as tire cord are nylon, polyester, steel, fiberglass, and aramids. Nylon and polyester are primarily used in the body or carcass of the tire. Steel, aramid, and fiberglass are primarily used in the belts between the carcass and the tread.

Cord production consists of twisting yarn on itself and then twisting two or more yarns together. Cords are then woven together to form fabric. None of the operations in cord production are a major VOC source.

An adhesive is then applied to the fabric to bond rubber to it. Adhesive must be applied under controlled conditions of time, temperature, and fabric tension. Bonding rubber to nylon is a particular problem. Fabric treatment operations are controlled and monitored by computers. The tire cord is coated by immersion in adhesive and removal of excess adhesive by vacuum or compressed air. The adhesive is generally waterbased.

Rubber compounds are applied to the fabric by a process called calendering. A calender is a machine equipped with three or more heavy rollers that rotate in opposite directions to those in direct contact with them. Rollers are heated by the circulation of water or steam through them. Gears permit the rollers to operate at varying speed ratios. One roller may move at the same speed or faster or slower than the rollers adjacent to it. The amount of rubber deposited onto the fabric is determined by the distance between rollers.

Rubber compounds for calendering should have little or no shrinkage, be tacky enough for tire-building operations, and exhibit good fabric adhesion. Warmup mills maintain uniform feedstock working properties so that a uniform layer of rubber can be applied to the fabric.

Usual practice is to coat fabric at the textile mill rather than at the tire plant. A coating operation supplying only one tire plant requires a disproportionate amount of capital, and one unit can produce enough coated fabric for several tire plants. Further, on a weight basis the shipping costs for coated and uncoated fabric are nearly the same.

Bead Production

The tire bead is made of rubber-coated steel that is formed into a hoop. The bead serves as the rim of the tire, holding the tire on the rim of the wheel and anchoring the plies. Extruded rubber is used to coat high-tensile-strength, brass-plated steel wire. Several layers of coated wire are formed into a hoop, and cement is applied to the bead by dipping, wiping, or spraying. Rubber-coated fabric may be wrapped around the bead; the assembly is sometimes dipped in adhesive to achieve a good bond between the bead and the sidewall.

The bead-cementing process, if performed by the tire manufacturer, is a source of emissions in a tire plant. Bead cement solvents include gasoline, hexane, isopropanol, naphtha, and toluene. Estimated VOC emissions from bead dipping in a typical

tire plant are 130 kg/day (290 lb/day). This emission is for an airstream of 5.4 m^3/s (11,400 cfm) containing 0.28 g VOC.m^3 (69 ppm).

Tire Building

Tire components are assembled in the tire-building operation to produce a "green" or uncured tire. Bias-ply and bias-belted tires are built on drums in a single-stage process. Radial tires are built in two or three stages. All tire building starts with a thin layer of special rubber called the inner liner being placed on the drum. The inner liner retains the air in a tire. Next, the plies are placed on top of the inner liner one ply at a time. The beads are then set in place and the plies are turned up around the beads. Belts, if any, are applied next. Finally the sidewalls and tread are added. The drum is collapsed and the green barrel-shaped tire is removed.

In radial tire building the green tire is generally expanded from a cylindrical (barrel) shape to a toroidal (doughnut) shape before adding the belts and treads. The belts and treads are then added to produce a green tire that resembles a distorted doughnut.

Tire building is a significant source of VOC emissions. In a typical tire plant, emissions from tire building have been estimated to be 500 kg/day (1100 lb/day). These emissions are from an airstream of 283 m^3/s (600,000 cfm) containing 0.02 g VOC/m^3 (5 ppm). The volume of this stream coupled with the low VOC concentration makes control of VOC emissions expensive and difficult.

Green Tire Spraying

Before molding and curing, green tires are sprayed with release agents. The spray removes air from the tire during curing and prevents the tire from sticking to the mold after curing. Sprays also aid in rubber flow during curing, cover tire blemishes, and add a shiny finish to the cured rubber. Either organic-based or water-based sprays can be used. If water-based

sprays are used, this operation is not a significant source of emissions. If an organic-based spray is used, emissions from this operation at a typical tire plant have been estimated at 1600 kg/day (3530 lb/day). Emissions are from an airstream of 23 m^3/s (48,400 cfm) containing 0.81 g VOC/m^3 (200 ppm).

Tire Curing and Finishing

Green tires are loaded into presses and cured (vulcanized) at temperatures of 100° to 200°C (212° to 400°F). In press curing, the tire is clamped into the mold and inflated with an air bladder. The rubber flows into the shape of the mold to form the desired tread pattern and wall thickness. Good flow depends on the plasticity of the uncured rubber. Flow must be complete before curing begins or the tire will be distorted. Proper flow is accomplished by adding fillers to control rubber plasticity, utilizing plasticizers, and controlling curing conditions. After curing, the mold is deflated and the tire is removed. The tire is then inflated and allowed to cool, and excess rubber is ground off. A final buffing and grinding of the tire insures balance. A blue or green water-based coating is applied to the white sidewalls to minimize scuffing during shipment and mounting on rims. Decals or other markings are sometimes applied with solvent-based inks, paints, or sprays.

TYPES OF TIRES

General Classes

The three kinds of pneumatic tires produced are bias ply, bias belted, and radial. Materials of construction and processing steps are similar for these tires. There are two differences, however, in the way the tires are built: (1) the angle or bias the plies make with the tread, and (2) the presence or absence of belts between the plies and the tread.

The bias-ply tire is the original pneumatic tire. The reinforcing cords or plies extend diagonally across the tire from

bead to bead at an angle of 30° to 40°. Each ply runs in an opposite direction to the plies above and below it.

The bias-belted tire represents an intermediate step between the bias-ply tire and the radial tire. It can be made on conventional tire-building equipment. Radial tires are built in a two- or three-step process and require special equipment. Tire manufacturers in the United States have produced large numbers of bias-belted tires as replacement equipment. Like the bias-ply tire, the reinforcing cords or plies extend diagonally across the tire from bead to bead. The angle is generally 25° to 40°. Between the plies and the tread are belts that are also at an angle to the tread. This angle is between 20° to 30°, with the belt angle being at least 5° less than the cord angle. Each belt runs in a different direction from the belts above and below it.

The radial tire has the carcass plies running parallel to the axis of the tire. As in the bias-belted tire, there are belts between the plies and the tread. These belts are nearly perpendicular to the carcass plies and serve to reinforce the carcass plies and to provide stability under stress such as in a sharp turn.

Passenger and Truck Tires

A passenger tire is typically assembled in 5 minutes or less by one worker. Much of the operation is automated in plants that manufacture new car tires. Long production runs on one tire size are usually scheduled. Those plants manufacturing replacement tires are usually less automated because they make several sizes of tires on a short-run basis.

Large tires (such as truck tires) require more time for assembly. A team of workers may be needed to manufacture the larger tires. A truck tire usually has more natural rubber than a passenger tire. Because natural rubber has a higher green strength than synthetic rubber, it is much harder to break down. It also usually requires more solvent to render it tacky enough to work. The VOC emissions from truck tire manufacturing are

probably greater per tire than from passenger tire manufacturing. Natural rubber is more puncture-resistant than synthetic rubber.

Industrial and Other Tires

Major tire manufacturers also produce industrial tires. These tires are used on forklift trucks and other industrial vehicles. A number of small manufacturers produce industrial tires. Only seven of them make pneumatic tires. Pneumatic tires appear to be a minor part of their manufacturing effort.

VOC EMISSIONS OF VOLATILE ORGANIC COMPOUNDS

According to the CTG, the four VOC emission processes that have been identified for control are undertread cementing, tread-end cementing, bead dipping, and green tire spraying. No practical control technology exists for tire building. Table 3 lists parameters and estimated VOC emissions from a model tire plant producing 16,000 passenger tires per day. All emissions are at temperatures ranging from 18° to 27°C (65° to 80°F).

Undertread Cementing

The model tire plant has four undertread cementing units. Estimated VOC emissions from each unit are 380 kg/day (840 lb/day) in an airstream of 2.8 m^3/s (5900 cfm). The VOC content is 1.57 g/m^3 (385 ppm). Total estimated emissions for this processing step are 1520 kg/day (3350 lb/day) in an airstream of 11.2 m^3/s (23,600 cfm).

Tread-end Cementing

The model tire plant has four tread-end cementing units. Estimated VOC emissions from each unit are 60 kg/day (130 lb/day) in an airstream of 3.9 m^3/s (8260 cfm). The VOC content is 0.18 g/m^3 (44 ppm). Total estimated emissions for this processing step are 240 kg/day (530 lb/day) in an airstream of 15.6 m^3/s (32,080 cfm).

TABLE 3. PARAMETERS FOR A TYPICAL PLANT MANUFACTURING 16,000 TIRES/DAY

Process	Number of units	Production, tires/day per unit	VOC emissions		Exhaust gas flow rate, m^3/s per unit (ft^3/min per plant)	VOC concentration of exhaust gas, g/m^3 (ppm^a)
			kg/day per unit	kg/day		
Undertread cementing	4	4020	380	1520	2.8 (23,600)	1.57 (385)
Tread-end cementing	4	4020	60	240	3.9 (32,800)	0.18 (44)
Bead dipping	2	8050	65	130	2.7 (11,400)	0.28 (69)
Tire building	50	320	10	500	5.7 (600,000)	0.02 (5)
Green tire spraying	5	3220	320	1600	4.6 (48,400)	0.81 (200)

[a]Calculation based on an average molecular weight of 100.

Bead Dipping

Tire plants using a bead-dipping process usually have two units. Estimated VOC emissions from each unit are 65 kg/day (140 lb/day) in an airstream of 3.7 m^3/s (5700 cfm). The VOC content is 0.28 g/m^3 (69 ppm). Total estimated VOC emissions for this processing step are 130 kg/day (290 lb/day) in an airstream of 5.4 m^3/s (11,400 cfm).

Tire Building

The model tire plant has 50 processing units. Estimated VOC emissions from each unit are 10 kg/day (20 lb/day) in an airstream of 5.7 m^3/s (12,100 cfm). The VOC content is 0.02 g/m^3 (5 ppm). Total estimated emissions for this processing step are 500 kg/day (1100 lb/day) in an airstream of 285 m^3/s (600,000 cfm). Because of the large air volume and low VOC content of this processing stream, no economically acceptable control measures have been suggested; VOC emissions from this stream will probably not be controlled.

Green Tire Spraying

The model tire plant has five green-tire-spraying units. Estimated VOC emissions from each unit are 320 kg/day (700 lb/day) in an airstream of 4.6 m^3/s (9700 cfm). The VOC content is 0.81 g/m^3 (200 ppm). Total estimated emissions for this processing step are 1600 kg/day (3530 lb/day) in an airstream of 23 m^3/s (48,400 cfm).

SECTION 4

CONTROL TECHNOLOGY AND FACTORS AFFECTING ENFORCEMENT

In December 1978, the EPA Office of Air Quality Planning and Standards (OAQPS) issued a CTG that specified means of controlling VOC emissions from the manufacture of pneumatic rubber tires. Model regulations based on reasonably available control technology (RACT) have been formulated for this industry. This section briefly describes RACT and the factors affecting enforcement.

SUMMARY OF THE REGULATIONS

On the basis of the control technology recommended in the CTG document, regulations affecting existing VOC sources of emission will be developed by the States for pneumatic tire manufacturers.

The regulations apply to undertread cementing, tread-end cementing, bead dipping, and green tire spraying. The regulations do not apply to specialty tire production for antique or other vehicles when produced on an irregular or short-run basis and when using equipment separate from normal production lines.

The regulation guidelines call for the owner or operator of an undertread cementing, tread-end cementing, or bead-dipping operation to reduce VOC emissions by:

Installing and operating a capture system designed to capture up to 85 percent by weight of VOC emitted from all undertread cementing, tread-end cementing, and bead-dipping operations, and

Installing and operating a control device that meets the requirements of one of the following:

A carbon adsorption system designed and operated to achieve a 95 percent removal of VOC from the gases ducted to the control device, or

An incineration system that oxidizes at least 90 percent of the nonmethane VOC's (measured as total combustible carbon) which enter the incinerator to carbon dioxide and water, or

An alternative VOC emission reduction system certified by the owner or operator to have at least a 90 percent reduction efficiency, measured across the control system, and which has been approved by the EPA.

For green-tire spraying operations, the owner or operator shall reduce VOC emissions by:

Substituting water-based sprays for the normal solvent-based mold release compounds; or,

Installing a capture system designed and operated in a manner that will capture and transfer at least 90 percent of the VOC emitted by the green-tire spraying operation to a control device, and in addition, install and operate a control device that meets the requirements of one of the following:

A carbon adsorption system designed and operated to achieve a 95 percent removal of VOC from the gases ducted to the control device, or

An incineration system that oxidizes at least 90 percent of the nonmethane VOC's to carbon dioxide and water, or

An alternative VOC emissions reduction system certified to have at least a 90 percent reduction efficiency, measured across the control device, and which has been approved by the EPA.

For the carbon systems, maximum reasonable capture should be consistent with the following guides:

American Conference of Governmental Industrial Hygienists. Industrial Ventilation, A Manual of Recommended Practices. 15th ed., 1978.

U.S. Department of Health, Education, and Welfare. National Institute of Occupational Safety and Health. Recommended Industrial Ventilation Guidelines. NIOSH 76-162, 1976.

If the regulations are promulgated by July 1, 1980, then the owner or operator of an undertread cementing, tread-end cementing, bead-dipping, or green-tire spraying operation subject to this regulation may, instead of implementing the measures required above, submit a petition for alternative controls before September 15, 1980. The alternative control plan is not effective until it is submitted and approved by the EPA Administrator as a State Implementation Plan revision.

Typical compliance schedules should call for the owner or operator of a pneumatic rubber tire manufacturing plant to meet the following increments of progress: (Note: Item dates assume promulgation by July 1, 1980, and should be adjusted to reflect the actual date of promulgation.)

For process equipment changes, low solvent technology, and add-on control devices, including incineration with heat recovery:

Submit final plans for the emission control system before October 15, 1980;

Award contracts or purchase orders for the emission control system before December 15, 1980;

Initiate onsite construction or installation of the emission control device before May 1, 1981;

Complete onsite construction or installation of the emission control device before May 1, 1982; and,

Achieve final compliance before July 1, 1982.

For incineration without heat recovery and substitution of water-based spray in the green-tire spraying operation, a typical compliance schedule might be:

Submit final plans before September 15, 1980;

Award all contracts or purchase orders before November 15, 1980;

Initiate onsite construction or installation before January 15, 1980;

Complete onsite construction or installation before May 15, 1981; and,

Achieve final compliance before July 1, 1981.

The owner or operator of a pneumatic rubber tire manufacturing plant may submit a proposed alternative compliance schedule provided:

The proposed alternative compliance schedule is submitted before September 15, 1980;

The owner or operator provides information showing the need for an alternative schedule;

The alternative compliance schedule contains increments of progress;

Sufficient documentation and certification from appropriate suppliers, contractors, manufacturers, or fabricators is submitted by the owner or operator of the volatile organic compound source to justify the dates proposed for the increments of progress; and,

Final compliance is achieved as expeditiously as possible and before the photochemical oxidant attainment date.

A 2-year schedule is recommended for add-on control equipment and process changes requiring the purchase of equipment, except for incineration systems without heat recovery. A 1-year schedule is recommended for installation of incineration systems without heat recovery, or process modifications not requiring the purchase of equipment. The compliance schedules presented here assume that July 1, 1980, is the effective date of the regulation.

The owner or operator of a VOC source shall demonstrate compliance by the methods outlined below, or by an alternative EPA approved method.

U.S. Environmental Protection Agency. Measurement of Volatile Organic Compounds. Guideline Series document. EPA-450/2-78-041, 1978.

U.S. Environmental Protection Agency. Control of Volatile Organic Emissions from Existing Stationary Sources. Volume

II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks. Appendix A. EPA-450/2-77-008, 1977.

The EPA may accept, instead of green-tire spray analysis, a certification by the manufacturer of the green tire spray, if supported by actual batch formulation records.

If add-on control equipment is used, the following parameters shall be monitored continuously.

Exhaust gas temperatures of incinerators

Temperature rise across a catalytic incinerator bed

Breakthrough of VOC on a carbon adsorption unit

Any other continuous monitoring or recording device required by the U.S. Environmental Protection Agency.

RACT FOR THE PNEUMATIC TIRE MANUFACTURING INDUSTRY

The following information is needed to determine the control methods that can be used on any or all of the emission streams found in a tire plant.

Treated air volumes

Airflow rates

Controlled VOC quantities

VOC process stream concentrations

Process airstream VOC definition

Permissible worker VOC exposure concentrations

VOC explosive limits

Table 3 (in Section 3) shows the estimates of VOC emissions and concentrations as well as the process airstream quantities and flow rates given in the CTG. Table 4 shows the threshold limit values (as established by the American Conference of Governmental Industrial Hygienists, or ACGIH), and the VOC explosive limits.

TABLE 4. THRESHOLD AND EXPLOSIVE LIMIT VALUES OF SOLVENTS USED IN THE TIRE INDUSTRY.

Solvent	Threshold limit values for continuous exposure[a]		Explosive limit	
	ppm	mg/m^3 air	Lower limit, %	Upper limit, %
Benzene	10	30	1.3	7.1
Gasoline	b	b	1.4	7.6
Hexane	100	360	1.2	7.5
Isopropanol	400	980	2.0	12.0
Naphtha	100[c]	400	Flash point -	100°F (38°C)
Toluene	100	375	1.27	7.0

[a]As established by the American Conference of Governmental Industrial Hygienists.

[b]Depends on aromatic content.

[c]Permissible workplace level as established by the Occupational Safety and Health Administration.

Proposed Control Measures

Thermal Incineration--

In thermal incineration, fuel is combined with air and the VOC stream, and the mixture is burned in an incinerator. If primary heat recovery is used to reduce fuel consumption, the exit temperature of the flue gas is reduced to about 800°F. This low-temperature flue gas has little use except for heating makeup air for the facility ventilation system. The quantity of heat produced by the afterburners greatly exceeds the needs of the average tire plant.

Catalytic Incineration--

Catalytic incineration burns the captured VOC in the presence of a catalyst. The catalyst enhances combustion so that less fuel is needed than for conventional incineration. Catalytic combustion temperatures are lower [425° to 625°C (800° to 1200°F)] than conventional incineration temperatures [about 800°C (1400°F)]. Rubber compounding ingredients such as sulfur and metal-organic compounds may contaminate the catalyst surface, and consequently the catalyst must be regenerated. This adds to the operating and maintenance cost of the system. Also, fuel to operate the incinerator is in short supply, and costs are high. As with thermal incinerators the heat recovered from catalytic incinerators is difficult to use in tire-making plants.

Carbon Adsorption--

The most suitable alternative for VOC control appears to be carbon adsorption, especially for the undertread cementing operation. Carbon adsorption controls VOC emissions by removing them from the exhaust stream. When the bed is saturated, the organic solvent is recovered by heating the bed. Steam is usually passed through the bed to vaporize the adsorbed solvent. The steam/VOC mixture is condensed and separated in a decanter. The solvent is transferred to a storage tank to be reused.

Other Control Techniques--

A study of other industries[2,3] has been conducted to find methods for controlling VOC emissions that might be applied to the pneumatic tire industry. A control method was considered if it has been used successfully and if a detailed description of it has been published. Two possible VOC control strategies were found:

Use of a process boiler as an afterburner

Cleanup and recirculation of process airstreams to the plant area, thus reducing heating and cooling costs

Process boiler afterburner--The VOC airstream is fed to the process steam boiler. The VOC's are recovered as fuel and need not be removed from the atmosphere. Afterburner boilers have been successfully used in meat smokehouses, rendering cookers, and oil refineries.

Several conditions must be met before using a process steam boiler as an after-burner.

1. Air contaminants must be combustible. Inorganic dusts and fumes foul heat transfer surfaces and result in reduce boiler efficiency.

2. The volume of contaminated gases cannot exceed boiler air requirements. If it does, combustion will be incomplete.

3. An adequate flame must be maintained in the boiler firebox to avoid explosive conditions.

The use of a process boiler to control VOC emissions has several advantages: (1) low capital investment (2) use of the boiler as the control device, and (3) fuel savings (if the VOC stream has heating value).

Several disadvantages are also present: (1) need for a standby boiler, (2) distance from the source to the boiler, requiring excess ductwork, and (3) problems from boiler tube and burner fouling. Caution also must be exercised to avoid explosive conditions.

Cleanup and recirculation of process airstreams--Process airstreams can be returned to the plant area to save heating or cooling costs if VOC's can be removed. This control method is most likely to be appropriate for a high volume airstream with a low VOC concentration because the product desired is the heated or cooled air. The economic consideration is whether or not reduced heating or cooling costs will offset the cost of removing the VOC's.

VOC CONTROL STRATEGIES FOR VOLATILE ORGANIC COMPOUNDS

Undertread Cementing

The model regulation indicates that either incineration or carbon adsorption can be used to control VOC emissions from undertread cementing. Two companies use carbon adsorption controls on the undertread cement line. With rising fuel costs and fuel shortages, carbon adsorption appears to be the most suitable control measure for undertread cementing. The costs and availability of fuel for incineration in all probability may make this option prohibitive.

Bead Cementing

Of the processes used in bead cementing, the model regulation only considers controlling VOC emissions from bead-dipping. Only 35 percent of the plants use this particular process. The regulation does not mention bead spraying or bead wiping. At some plants, bead cementing is not even used. The RACT for this process can be either incineration or carbon adsorption.

Before controls can be developed for bead dipping, the operation at each plant must be evaluated for VOC emissions. Some operations may emit insignificant VOC amounts and thus not require control measures. According to tire manufacturers, bead dipping for each day's production is completed in 3 to 4 hours. Simply covering the dip tanks when they are not in use would reduce VOC emissions.

Tread-End Cementing

The model regulation shows incineration and carbon adsorption to be effective VOC control measures for tread-end cementing. Spray application of tread-end cement accounts for about 6 percent of the VOC emissions, or 66 tons/yr from a tire plant. Hand application is done in 65 percent of the plants and is believed to reduce emissions up to 75 percent.[4] Further study is needed to assess VOC emissions from each operation and to gather data comparing VOC emissions during hand application and spray application of cement.

Green Tire Spraying

In green-tire spraying operations, solvent-based sprays are being replaced by water-based sprays because of the cost of organic solvents, the availability of the solvents, and the need to reduce VOC emissions. Solvent-based sprays are estimated to account for 38 percent of the organic solvent emissions from tire plants. Currently 32 percent of the plants use water-based sprays, which are considered RACT for this process.

FACTORS AFFECTING REGULATION ENFORCEMENT

Enforcement and compliance will follow the adoption of guideline regulations for the pneumatic tire industry. Problems will be encountered in determining applicability, required control efficiency, and compliance; in applying the "bubble concept"; and in meeting compliance schedules.

Determining Applicability

Although PEDCo has had several meetings with industry and EPA representatives about the sources covered by this regulation, some confusion still exists. We met with representatives of the Rubber Manufacturers Association (RMA) on March 10, 1980. At that time they believed that the regulations only applied to truck and automobile pneumatic tire plants. They did not believe that the regulations applied to small industrial pneumatic tire

manufacturers. The representatives had just discovered the discussion on tread rubber manufacturers in the model regulations, and agreed that this segment of the industry appeared to be covered. They said that the model regulations were the first indications that the tread rubber group would be regulated. The RMA representatives, in several meetings and discussions with EPA staff, had never discussed regulation of the tread industry.

We had met previously, on November 20, 1979, with a representative of EPA's Office of Air Quality Planning and Standards. He indicated that pneumatic bicycle tires are not covered by the regulations even though they qualify by size and by definition of passenger tires.

The regulations currently cover 94 plants. If the regulations were limited to automobile and small truck tire manufacturers, decisions about applicability would be greatly simplified. The industrial pneumatic tire plants might be exempt in light of the clause excluding "irregular basis and short production runs"; however, the state must decide.

Various problems also arise in applying the regulations to tread rubber manufacturers. Tread rubber is made by two processes; cold cap and Orbitread. Only the cold cap process uses undertread cement at central manufacturing facilities.

Some large retread plants produce their own tread rubber and use undertread cementing. These plants were not included in the PEDCo survey. Although recapping operations are excluded in the regulations, the undertread cement operations in retread plants are included.

Determining Required Control Efficiency

When PEDCo first examined the regulations, we were perplexed at the "up to" capture clauses. Although a goal of 85 percent capture efficiency is admirable, it is unenforceable in practical terms. After visiting several plants, we were able to clarify the capture problems. Each rubber tire plant is so different that a uniform capture efficiency cannot be set. In practice,

the capture efficiency for each system will be negotiated on a case-by-case basis.

Although the "up to" clause was intended to allow individual variations, the states have not interpreted it as such. Officials in one state, for example, deciding that the "up to" clause was unenforceable, specified a 90 percent capture efficiency in their preliminary regulation. This state regulation is thus even more stringent than the model regulation because it uses the New Source Performance Standard (NSPS) capture efficiency (90 percent) rather than the CTG efficiency (up to 85 percent). We believe that EPA should clarify the policy by stating that capture efficiency should be determined on a case-by-case basis.

Representatives from RMA indicated that the model regulations for undertread cementing are based on flow rates at the Goodyear plant in Lawton, Oklahoma. At this new plant, collection hooding and control equipment were installed with the undertread cementing line. Exhaust flow rates are low in comparison with rates from the various systems that will be required in other plants. Therefore, the control costs shown in the CTG are understated. Another problem in the CTG is the annual operating period that is used as a basis for calculating cost. Tire plants operate 250 days per year, not 365. When 365 days is used as the basis, the RMA believes control costs are understated for each of the four affected processes.

The RMA representatives emphasized the impact of these model regulations on older plants. If each plant is evaluated on a case-by-case basis, however, this problem will be eliminated. Many older plants are also being closed as sales decline and radial tires replace conventional tires.

Determining Compliance

Capture Efficiency--

VOC capture efficiency can only be determined by a material balance. No devices are available for the continuous measurement of fugitive emissions, waste, cleanup solvents, and the solvents

that are retained in the product. Thus, an inspector cannot determine the VOC capture efficiency of collection systems in the field. Initial compliance should be determined via a material balance in conjunction with a permit application or permit renewal. At this stage, the company and the control agency can agree on estimates of solvent retained in the product and on rate of solvent evaporation. They can also establish recordkeeping requirements for solvent usage, recovered solvent, production, and waste or surplus solvent disposal.

The tire industry maintains records of total solvent purchases. None of the plants that we visited, however, keeps records of solvent consumption by operation. Because records are not now being kept, the industry will probably resist a requirement to record solvent usage by process application.

Some states cannot use company records to show noncompliance. In California, for example, purchase records are required. Rubber tire plants buy their solvent in bulk, however, for use in all operations.

Control Efficiency/Compliance Monitoring--

The efficiency of control equipment can be determined by measuring the inlet and outlet VOC concentrations during stack tests. Breakthrough indicators continuously monitor compliance on carbon adsorbers. The cost ($20,000) of this instrument is reasonable when compared with the total cost of a large carbon adsorption system ($250,000). Inlet and outlet temperature indicators continuously monitor compliance on incinerators. Although temperature indicators monitor the proper operation of an incinerator, they are not as effective as the breakthrough indicator that is required on the carbon adsorber.

The Bubble Concept

In the bubble concept, compliance is based on emissions from the plant as a whole. Because the regulations cover emissions from several tire plant operations, the bubble concept will help

the industry to comply. Before the concept can be applied, however; the "up to" clause must be clarified. The clause makes it difficult to allow one source to be overcontrolled so that another can be undercontrolled.

The industry will shift to water-based coatings for use in green tire spraying. With an incentive, such as these regulations, the industry will also control undertread cementing. For economic reasons, however, the industry will resist controlling tread-end cementing and bead dipping. Many tire manufacturers do not have automatic tread-end cementing or bead dipping operations. The model tire plant used as a guide in this report is atypical in many respects. Of the production lines surveyed, only 35 percent used spraying for tread-end cementing, and 35 percent use bead dipping. When tread-end cementing is performed manually rather than by spraying, VOC emissions are reduced up to 75 percent.[4] As a result this technique should be included within the bubble concept. Bead wiping also reduces VOC emissions when compared with bead dipping, and should be allowed. After taking into account these process variations, the application of the bubble concept to pneumatic tire making.

Compliance Schedules

The rubber tire industry's primary problem in meeting compliance schedules is reformulating the green tire spray. The longer schedule proposed for heat recovery may be unnecessary.

Formulation Changes--

Tire manufacturers have more product liability problems than most industries, because tire failures can result in huge personal injury lawsuits. This risk causes manufacturers to hesitate to change processing techniques. Process changes are usually evaluated in the laboratory and then by road testing under controlled conditions. Testing may take as long as a year.

Tire companies have taken up to 4 years to convert from solvent-based green tire sprays to water-based sprays. Some companies have just started the process. The companies may not

complete the process changes, including product testing, within the 2 years proposed in the model regulations. The EPA should provide guidance for situations where compliance will be delayed by formulation changes and product testing. A standard method of obtaining extensions for formulation changes should be established. Partial compliance is also possible when plants are able to use water-based sprays to a limited extent. Guidelines should be established for situations where partial compliance is possible.

Heat Recovery--

The addition of 12 months to the compliance schedule for incinerators with heat recovery is excessive. The compliance schedule for incinerators without heat recovery is too short; 18 months is more appropriate. The savings in energy costs will encourage the use of heat recovery by the few, if any, companies that choose this option; thus a compliance schedule incentive is not needed.

SECTION 5

STATUS OF STATE PROGRAMS

STATE AIR CONTROL AGENCIES

PEDCo contacted air quality control agencies in 27 states and Puerto Rico by telephone. These agencies all have pneumatic tire and/or tread rubber manufacturing plants within their jurisdictions. The purpose of the contacts was to determine the status of state programs for VOC control, to supplement our list of manufacturers, and to determine potential enforcement problems.

The agency responses can be grouped into five categories:

A. They have proposed or are proposing specific regulations for the manufacturing of pneumatic tires.

B. They have existing regulations regarding VOC emissions.

C. They will follow the Federal lead when the situation is clarified.

D. They are not affected because plants are located in attainment areas.

E. They have a regulation covering the entire rubber industry.

Table 5 lists the states that are included in each category. The categories are not mutually exclusive; two states (North Caroline and Virginia) appear twice.

California is proposing the following regulations:

1. Undertread cementing and bead dipping would be controlled by carbon adsorption. Any undertread-cementing operation emitting less than 200 lb/day for the entire facility is exempt. Any bead-dipping operation emitting less than 100 lb/day for the entire facility is exempt.

TABLE 5. STATUS OF STATE REGULATION OF VOLATILE ORGANIC COMPOUND EMISSIONS FROM TIRE AND TREAD RUBBER PLANTS.

A.	Have proposed or are proposing regulations covering the manufacturing of pneumatic tires:		
	Illinois	California	Ohio
	North Carolina	Pennsylvania	Wisconsin
B.	Have regulations covering VOC emission:		
	Indiana	Kentucky	North Carolina
	Virginia	Puerto Rico	
C.	Have no regulations, but will follow the Federal lead:		
	Alabama	Massachusetts	South Carolina
	Connecticut	Michigan	Tennessee
	Georgia	New York	Texas
	Iowa	Oklahoma	
D.	Are not affected because plants are in attainment areas:		
	Arkansas	Maryland	Oregon
	Kansas	Mississippi	Virginia
	Maine		
E.	Has a regulation covering the entire rubber industry:		
	New Jersey		

2. Tread-end cementing would be controlled by hand application of cement, with an emissions limit of 200 lb/day. This limit is equivalent to about 5 grams of VOC per tire compared, with emissions of about 20 grams per tire when cement is applied by spray. Any tread-end cementing operation emitting less than 200 lb/day for the entire facility is exempt.

3. Green tire spraying would be controlled by using a water-based spray that cannot contain more than 3 percent VOC.

4. No controls would be required for the tire-building process.

5. Sources emitting less than 200 lb/day would be exempt. This exemption would apply to all tread rubber plants in California.

Efforts in other states have been more modest. Pennsylvania and Ohio have conducted discussions with the tire industry in an effort to establish workable controls and to have the benefit of input from the industry, but neither state has yet published proposed regulations.

Some state air control agencies believe that the pneumatic tire industry can be controlled under existing VOC regulations. A blanket regulation requiring 85 percent VOC control meets the requirements of the CTG. Success in controlling 85 percent of the VOC emissions depends heavily on the capture efficiency of the system.

Several state air control agencies with tire plants in attainment areas feel they do not need VOC regulations for tire manufacturers. Other state air control agencies will not act until NSPS regulations become effective and until pending VOC control lawsuits are settled.

New Jersey regulations cover the entire rubber industry. The State does not list any pneumatic tire manufacturing facilities. PEDCo found that the Super Tire Engineering Company manufactures pneumatic tires, but the company has only 350 employees as compared with 1000 to 1200 employees for an average tire plant. Their primary product is solid rubber tires, and

consequently the pneumatic tire production may be low enough to exempt the company from any proposed regulation. Another company, the Oliver Tire and Rubber Company, manufactures tread rubber. That plant may be subject to regulation.

REFERENCES

1. U.S. Environmental Protection Agency. Control of Volatile Organic Emissions From Manufacture of Pneumatic Rubber Tires. EPA-450/2-78-030. December 1978.

2. U.S. Department of Health, Education, and Welfare. A Recommended Approach to Recirculation of Exhaust Air. DHEW (NIOSH) Publication No. 78-124. January 1978.

3. U.S. Environmental Protection Agency. Air Pollution Engineering Manual, Second Edition. AP-40, Chapter 5. May 1973.

4. State of California Air Resources Board. Consideration of a Control Strategy for Volatile Organic Compound Emissions from the Manufacture of Pneumatic Rubber Tires. October 1979.

APPENDIX

PNEUMATIC TIRE AND TREAD MANUFACTURERS INVENTORY

The following tables present an inventory of pneumatic tire and tread rubber plants by EPA region and within each state or territory. For the reader's convenience, regions, states, and territories that do not have such plants have been deleted from the tables.

TABLE A-1. OPERATING PLANTS IN REGION I.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
Connecticut	1 (0/1)			12.0		
Maine		1 (0/1)			2.0[2]	
Massachusetts	1 (0/1)			26.5		
Total	2 (0/2)	1 (0/1)		38.5	2.0	

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.
[2]Estimate based upon employment level.

TABLE A-2. OPERATING PLANTS IN CONNECTICUT.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Armstrong Rubber Co. West Haven	New Haven	42	N	12.0		
Total 1			A=0:N=1	12.0		

[1]A = attainment: N = nonattainment

TABLE A-3. OPERATING PLANTS IN MAINE.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Industrial tire plant						
Rubber International Westbrook	York	110	N		2.0	
Total 1			A=0:N=1		2.0	

[1]A = attainment: N = nonattainment.

TABLE A-4. OPERATING PLANTS IN MASSACHUSETTS.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Uniroyal Tire Co. Chicopee Falls	Hampden	42	N	26.5		
Total 1			A=0:N=1	26.5		

[1]A = attainment: N = nonattainment.

TABLE A-5. OPERATING PLANTS IN REGION II.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
New Jersey	1 (0/1)		1 (0/1)	4.0		50
New York	1 (0/1)			16.2		
Puerto Rico			1 (1/0)			25
Total	2 (0/2)		2 (1/1)	20.2		75

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.
[2]Estimate based upon employment level.

TABLE A-6. OPERATING PLANTS IN NEW JERSEY.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Super Tire Engineering Co. Pennsauken	Camden	45	N	4.0		
Tread rubber plant						
Oliver Tire and Rubber Co. Flemington	Hunter-down	151	N			50
Total 2			A=0:N=2	4.0		50

[1]A = attainment: N = nonattainment.

TABLE A-7. OPERATING PLANTS IN NEW YORK.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Dunlop Tire and Rubber Co. Tonawanda	Erie	162	N	16.2		
Total 1			A=0:N=1	16.2		

[1]A = attainment: N = nonattainment.

TABLE A-8. OPERATING PLANTS IN PUERTO RICO.

Name and address of plant	County	AQCR	Status[1]	Capacity		
				1000 tires/day		1000 lb/day
				Car/truck	Industrial	Tread rubber
Tread rubber plant						
Tristiana Rubber Industries San Juan	None	244	A			25
Total 1			A=1:N=0			25

[1]A = attainment: N = nonattainment.

TABLE A-9. OPERATING PLANTS IN REGION III.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
Maryland	1 (1/0)			19.0		
Pennsylvania	4 (0/4)		1 (0/1)	62.5		70
Virginia	2 (1/1)		1 (0/1)	20.5		35
Total	7 (2/5)		2 (0/2)	102.0		105

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.

TABLE A-10. OPERATING PLANTS IN MARYLAND.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Kelly-Springfield Tire Co. (Subsidiary of Goodyear) Cumberland	Allegheny	113	A	19.0		
Total 1			A=1:N=0	19.0		

[1]A = attainment: N = nonattainment.

TABLE A-11. OPERATING PLANTS IN PENNSYLVANIA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Carlisle Tire and Rubber Co. Carlisle	Cumberland	196	N	16[2]		
Firestone Tire and Rubber Co. Pottstown	Montgomery	45	N	23.5		
B. F. Goodrich Oaks	Montgomery	45	N	19.0		
McCreary Tire and Rubber Co. Indiana	Indiana	197	N	4.0		
Tread rubber plant						
Mohawk Rubber Co. Lancaster	Lancaster	196	N			70
Total 5		A=0:N=5		62.5	70	

[1]A = attainment: N = nonattainment.
[2]Not all of production subject to proposed regulation.

TABLE A-12. OPERATING PLANTS IN VIRGINIA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Goodyear Tire and Rubber Co. Danville	Pott-sylvania	222	A	7.0		
Mohawk Rubber Co. Roanoke	Roanoke	226	N	13.5		
Tread rubber plant						
Brad Ragan Rubber Corp. Radford	Mont-gomery	226	N			35
Total 3		A=1:N=2				35

[1]A = attainment: N = nonattainment.

TABLE A-13. OPERATING PLANTS IN REGION IV.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
Alabama	5 (4/1)	1 (1/0)	3 (3/0)	115.5	0.5	130
Georgia	1 (1/0)		5 (3/2)	27.3		350
Kentucky	1 (1/0)	1 (1/0)		34.0	5.0	
Mississippi	1 (1/0)			13.5		
North Carolina	3 (2/1)	1 (1/0)	4 (3/1)	69.5	1.0	200
South Carolina	2 (2/0)		1 (1/0)	26.5		20
Tennessee	4 (1/3)	1 (0/1)		82.4	0.2	
Total	17 (12/5)	4 (3/1)	13 (10/3)	368.7	6.7	700

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.

TABLE A-14. OPERATING PLANTS IN ALABAMA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Dunlop Tire and Rubber Co. Huntsville	Madison	7	N	14.0		
B. F. Goodrich Tuscaloosa	Tusca-loosa	4	A	30.0		
Goodyear Tire and Rubber Gadsden	Etowah	3	A	46.0		
Michelin Tire Dothan	Houston	6	A	6.0		
Uniroyal Tire Co. Opelilo	Lee	2	A	19.5		
Industrial tire plant						
Sterling Tire Co. Tuscambia	Colbert	7	A		0.5	
Tread rubber plant						
Mohawk Rubber Co. Guntersville	Mar-shall	7	A			25
Robbin Tire and Rubber Co. Tuscambia	Colbert	7	A			60
OK Tire and Rubber Co. Guntersville	Mar-shall	7	A			45
Total 9			A=8:N=1	115.5	0.5	130

[1]A = attainment: N = nonattainment.

TABLE A-15. OPERATING PLANTS IN GEORGIA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Firestone Tire and Rubber Co. Albany	Dough-erty	59	A	27.3		
Tread rubber plants						
Associated Rubber Co. Tallapoosa	Haral-son	55	A			80
Bandag, Inc. Griffin	Spalding	56	N			100
General Tire and Rubber Macon	Bibb	54	A			50
Oliver Tire and Rubber, Div. of Standard Products Co. Athens	Clarke	57	A			80
Uniroyal Tire Co. Conyer	Rockdale	56	N			40
Total 6			A=4:N=2	27.3		350

[1]A = attainment: N = nonattainment.

TABLE A-16. OPERATING PLANTS IN KENTUCKY.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
General Tire and Rubber Co. Mayfield	Graves	72	A	34.0		
Industrial tire plant						
Goodyear Rubber Co. Madisonville	Hopkins	72	A		5.0	
Total 2			A=2:N=0	34.0	5.0	

[1]A = attainment: N = nonattainment.

TABLE A-17. OPERATING PLANTS IN MISSISSIPPI.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Armstrong Rubber Co. Natchez	Adams	134	A	13.5		
Total 1			A=1:N=0	13.5		

[1]A = attainment: N = nonattainment.

TABLE A-18. OPERATING PLANTS IN NORTH CAROLINA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plants						
Firestone Tire and Rubber Co. Wilson	Wilson	166	A	15.5		
General Tire and Rubber Charlotte	Mecklenberg	167	N	17.0		
Kelly-Springfield Tire Co. (Subsidiary of Goodyear) Fayetteville	Cumberland	169	A	37.0		
Industrial tire plant						
Wilmot Corp. Gaston	Gaston	167	A		1.0	
Tread rubber plants						
Bandag, Inc. Oxford	Granville	166	A			100
Harrelson Rubber Co. Asheboro	Randolph	136	A			60
Monkey Grip of North Carolina Charlotte	Mecklenberg	167	N			20
Patch Rubber Co. Roanoke Rapids	Northampton	166	A			20
Total 8			A=6: N=2	69.5	1.0	200

[1]A = attainment: N = nonattainment.

TABLE A-19. OPERATING PLANTS IN SOUTH CAROLINA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Michelin Tire Corp. Greenville	Greenville	202	A	25.0		
Michelin Tire Corp. Spartanburg	Spartanburg	202	A	1.5		
Tread rubber plant						
Long Mile Rubber Co. Spartanburg	Spartanburg	202	A			20
Total 3			A=3:N=0	26.5		20

[1]A = attainment: N = nonattainment.

TABLE A-20. OPERATING PLANTS IN TENNESSEE.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plants						
Armstrong Rubber Co. Madison (Nashville)	Davidson	208	N	17.5		
Firestone Tire and Rubber Co. Memphis	Shelby	18	N	23.0		
Firestone Tire and Rubber Co. Nashville	Davidson	208	N	1.9		
Goodyear Tire and Rubber Co. Union City	Obion	209	A	40.0		
Industrial tire plant						
Mitchell Industrial Tire Co. Chattanooga	Hamilton	55	N		0.2	
Total 5			A=1:N=4	82.4	0.2	

[1]A = attainment: N = nonattainment.

TABLE A-21. OPERATING PLANTS IN REGION V.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
Illinois	4 (2/2)	1 (0/1)		58.9	2.0	
Indiana	1 (0/1)			25.5		
Michigan	2 (0/2)			40.5		
Ohio	8 (0/8)	1 (0/1)	3 (0/3)	61.3	10.0	110
Wisconsin	1 (1/0)					
Total	16 (3/13)	2 (0/2)	3 (0/3)	186.2	12.0	110

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.

TABLE A-22. OPERATING PLANTS IN ILLINOIS.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Firestone Tire and Rubber Co. Bloomington	McLean	66	N	1.5		
Firestone Tire and Rubber Co. Decatur	Macon	75	N	25.3		
General Tire and Rubber Co. Mount Vernon	Jefferson	74	A	12.6		
Kelly-Springfield Tire Co. (Subsidiary of Goodyear) Freeport	Stephenson	73	A	19.5		
Industrial tire plant						
Bearcat Tire Co. (Subsidiary of Louis Fishman and Co.) Chicago	Cook	67	N		2.0	
Total 5			A=2:N=3	58.9	2.0	

[1]A = attainment: N = nonattainment.

TABLE A-23. OPERATING PLANTS IN INDIANA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
B. F. Goodrich Fort Wayne	Allen	81	N	25.5		
Total 1			A=0:N=1	25.5		

[1]A = attainment: N = nonattainment.

TABLE A-24. OPERATING PLANTS IN MICHIGAN.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Goodyear Tire and Rubber Co. Jackson	Jackson	125	N	24.5		
Uniroyal Detroit	Wayne	123	N	16.5		
Total 2			A=0:N=2	40.5		

[1]A = attainment: N = nonattainment.

TABLE A-25. OPERATING PLANTS IN OHIO.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Cooper Tire Co. Findlay	Hancock	177	N	14.4		
Dayton Tire and Rubber Co. (Subsidiary of Firestone, formerly Sieberling), Barberton	Summit	174	N	10.3		
Dayton Tire and Rubber Co. Dayton	Montgomery	173	N	18.6		
Denman Rubber Mfg. Co. Leavittsburg	Trumbull	178	N	4.4		
Firestone Tire and Rubber Co. Akron	Summit	174	N	4.5		
General Tire and Rubber Co. Akron	Summit	174	N	8.5		
General Tire and Rubber Co. Bryan	Williams	177	N	0.1		
B. F. Goodrich Akron	Summit	174	N	0.5		

(continued)

TABLE A-25. (continued)

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Industrial tire plants						
Teledyne-Monarch Hartville	Stark	174	N		10.0	
Tread rubber plants						
Baltic Rubber and Plastic Baltic	Tusca-ranas	183	N			20
Hercules Tire and Rubber Findlay	Hancock	177	N			70
Paeco Rubber Co. Ravenna	Portage	174	N			20
Total 12			A=0:N=12	61.3	10.0	110

[1]A = attainment: N = nonattainment.

TABLE A-26. OPERATING PLANTS IN WISCONSIN.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Uniroyal Eau Claire	Eau Claire	237	A	29.0		
Total 1			A=1:N=0	29.0		

[1]A = attainment: N = nonattainment.

TABLE A-27. OPERATING PLANTS IN REGION VI.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
Arkansas	1 (1/0)			21.1		
Oklahoma	4 (3/1)			90.1		
Texas	2 (1/1)		4 (2/2)	46.0		220
Total	7 (5/2)		4 (2/2)	157.2		220

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.

TABLE A-28. OPERATING PLANTS IN ARKANSAS.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Cooper Tire Co. Texarkana	Miller	22	A	21.1		
Total 1			A=1:N=0	21.1		

[1]A = attainment: N = nonattainment.

TABLE A-29. OPERATING PLANTS IN OKLAHOMA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
Dayton Tire and Rubber Co. (Subsidiary of Firestone) Oklahoma City	Oklahoma	184	N	23.5		
B. F. Goodrich Miami	Ottawa	186	A	12.6		
Goodyear Tire and Rubber Lawton	Comanche	189	A	22.0		
Uniroyal Tire Ardmore	Carter	188	A	32.0		
Total 4			A=3:N=1	90.1		

[1]A = attainment: N = nonattainment.

TABLE A-30. OPERATING PLANTS IN TEXAS.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plant						
General Tire and Rubber Co. Waco	McLennon	212	N	21.0		
Kelly-Springfield Tire Co. (Subsidiary of Goodyear) Tyler	Smith	22	A	25.0		
Industrial Tire plant						
Tread rubber plant						
Bandag, Inc. Abilene	Taylor	210	A			100
Long Mile Rubber Co. Dallas	Dallas	215	N			40
Monkey Grip Rubber Co. Dallas	Dallas	215	N			30
Oliver Tire and Rubber Co. (Div. of Standard Products Co.) Paris	Lamar	22	A			50
Total 6			A=3:N=3	46.0		220

[1]A = attainment: N = nonattainment.

TABLE A-31. OPERATING PLANTS IN REGION VII.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
Iowa	2 (0/2)		1 (0/1)	34.0		100
Kansas	1 (1/0)			28.5		
Total	3 (1/2)		1 (0/1)	62.5		100

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.

TABLE A-32. OPERATING PLANTS IN IOWA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plants						
Armstrong Rubber Co. Des Moines	Polk	92	N	14.5		
Firestone Tire and Rubber Co. Des Moines	Polk	92	N	19.5		
Tread rubber plant						
Bandag, Inc. Muscatine	Muscatine	69	N			100
Total 3			A=0:N=3	34.0		100

[1]A = attainment: N = nonattainment.

TABLE A-33. OPERATING PLANTS IN KANSAS.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Industrial	1000 lb/day Tread rubber
Car/truck tire plant						
Goodyear Tire and Rubber Co. Topeka	Shawnee	94	A	28.5		
Total 1			A=1:N=0	28.5		

[1]A = attainment: N = nonattainment.

TABLE A-34. OPERATING PLANTS IN REGION IX.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
California	3 (0/3)		4 (0/4)	31.6		240
Total	3 (0/3)		4 (0/4)	31.6		240

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.

TABLE A-35. OPERATING PLANTS IN CALIFORNIA.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Car/truck tire plants						
Armstrong Rubber Co. Hanford	Tulare	31	N	11.0		
Firestone Tire and Rubber Co. Los Angeles	Los Angeles	24	N	2.0		
Firestone Tire and Rubber Co. Salinas	Monterrey	25	N	18.6		
Tread rubber plants						
Bandag, Inc. Chino	San Bernadino	24	N			100
Burke Industries, Inc. San Jose	Santa Clara	30	N			60
Mohawk Rubber Co. Stockton	San Joaquin	31	N			30
Oliver Tire and Rubber Co. (Div. of Standards Products) Oakland	Contra Costa	30	N			50
Total 7			A=0:N=7	31.6		240

[1]A = attainment: N = nonattainment.

TABLE A-36. OPERATING PLANTS IN REGION X.

State	Plants (attainment/nonattainment)			Capacity[1]		
	Car/truck	Industrial	Tread rubber	Car/truck 1000 tires/day	Industrial 1000 tires/day	Tread rubber 1000 lb/day
Oregon			1 (0/1)			40
Total			1 (0/1)			40

[1]Estimate from January 1979 "Modern Tire Dealer," unless otherwise noted.

TABLE A-37. OPERATING PLANTS IN OREGON.

Name and address of plant	County	AQCR	Status[1]	Capacity 1000 tires/day Car/truck	Capacity 1000 tires/day Industrial	Capacity 1000 lb/day Tread rubber
Tread rubber plant						
Long Mile Rubber Co. Portland	Washington	193	N			40
Total 1			A=0: N=1			40

[1]A = attainment: N = nonattainment.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

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16. ABSTRACT Pneumatic rubber tires or tread rubber is manufactured by 94 plants located in the United States and Puerto Rico. Reasonably available control technology (RACT) requirements for the pneumatic rubber tire and tread rubber manufacturers apply to 55 plants located in photochemical oxidant nonattainment areas. The major processing steps in tire manufacturing are rubber compounding, tread rubber production, cord production, bead production, tire building, and tire curing and finishing. The following processes cause volatile organic compound (VOC) emissions from a typical pneumatic tire manufacturing plant: green tire spraying with organic-based solvents, undertread cementing, tire building, tread-end cementing, and bead dipping. Practical VOC control measures are carbon adsorption and use of water-based spray for green tire spraying. Hand application of cement for tread-end cementing may be an acceptable control provided emissions meet some arbitrary limit. No practical control measure has been found for the emissions from tire building. The potential enforcement problems appear to be determining the capture efficiency of the VOC collection device, determining compliance, applying the bubble concept, and meeting compliance schedules. This report provides an inventory of the pneumatic rubber tire and tread rubber manufacturing plants, an industry process description, a review of the RACT requirements, and an evaluation of the model regulations to identify enforceability problems.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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